Introduction to Low Energy Design

A Checklist

Excerpted from "Laboratories for the 21st Century"

The Opportunities

As in any building project, an energy-sensitive design process for facilities must be supported by a high degree of communication among the design team professionals. Energy-efficient design is invariably integrated design. Among other things, this means that the implications of design decisions on the performance of the whole building are understood and evaluated at each step of the process by the entire team. The opportunities described herein should be pursued as part of an iterative, cross-disciplinary effort in which each phase of the process influences and informs the others.

It is important to note that energy efficiency is just one piece of a larger commitment to sustainable design, which includes site optimization, water conservation, the use of environmentally preferable materials, and concern for the quality of the indoor environment. <u>All design decisions should be evaluated in the context and spirit of "reduce, reuse, recycle," a phrase that defines contemporary sustainable practices.</u>

The Checklist

- Planning & Programming
- Designing
- Engineering
- Commissioning, Operating & Maintaining
- Powering

Planning and Programming

During planning and programming, important decisions are made that will have a fundamental impact on the energy efficiency of the facility. These are some of the key recommendations for this phase of the design:

Planning and Programming Checklist:

- ❑ **Emphasize life-cycle costs when making decisions.**
- ❑ **Establish energy efficiency and the use of renewables as project goals.**
- ❑ **Conduct a codes and standards review.**
- ❑ **Understand the implications of narrow operating ranges.**
- ❑ **Catalogue the opportunities for energy efficiency and renewables in non-lab spaces.**
- ❑ **Segregate energy intensive processes by creating mini-environments.**

Designing

During the design phase of a project, criteria established in the planning and programming phase are translated into actual forms. Many decisions are made about elements that have a significant impact on energy consumption, such as adjacencies, building sections, service routes, and building envelope design. These are some key recommendations for this phase:

Designing Checklist:

- ❑ Select A/E professionals with experience in sustainable facilities design.
- ❑ Pursue a whole-building approach.
- ❑ Insist on clarity and convenience in mechanical systems distribution.
- ❑ Try to isolate office and support spaces from lab modules.
- ❑ Plan adjacencies by considering mechanical system requirements.
- ❑ Don’t forget about people!

Engineering

In energy-efficient laboratory design, it is critically important for the engineering design team to provide input to the architectural design team from the very outset. If this is not done, opportunities to integrate efficiency measures into the building can be lost as the design progresses. But even after a building is planned and its architectural schematics completed, many important engineering decisions remain. These are some key recommendations for the engineering phase:

Engineering Checklist:

- Be sure to right-size equipment.
- Select equipment by considering part-load and variable operating conditions.
- Specify premium high-efficiency equipment.
- Carefully consider the number, size, location, and type of fume hoods.
- Stress low-pressure-drop design.
- Take advantage of your unique climate and location.
- Separate low and high-temperature cooling loops.
- Consider using energy recovery systems.
- Incorporate energy-monitoring and control systems.

Commissioning, Operating & Maintaining

Even the most carefully designed and built project can fall far short of its performance goals if the building is not properly commissioned, operated, and maintained (CO&M). This means that concerns for CO&M must be incorporated into all phases of the design process. Commissioning a facility begins with a design-intent document that includes an outline of a comprehensive commissioning plan. And, with the participation of O&M personnel on the project review team, CO&M concerns should be reviewed during the design and engineering phase of each project. These are some recommendations for CO&M:

Commissioning, Operating & Maintaining Checklist:

- ❑ Requires whole building commissioning.
- ❑ Benchmark, monitor and report annually on building energy performance.

Powering

Many laboratories are located on large university or corporate campuses. Increasingly, these complexes are investigating the economic viability of on-site electric power generation or load-leveling options such as cogeneration or off-peak thermal energy storage. Both small and large projects can benefit from the application of distributed technologies, such as natural-gas-powered fuel cells. In some climates and utility districts, solar thermal or photovoltaic energy systems are also cost effective. These are some recommendations for powering a laboratory:

Powering Checklist:

- ❑ Investigate the application of on-site power generation.
- ❑ Consider using on-site renewable energy.
- ❑ Purchase “green power”.

Labs 21

Common Themes for Energy Efficiency

Labs and Energy

Labs can consume 3 times more energy per SF than other building types.

- Ventilation and Process-Dominated in any climate (cold, hot, humid, dry)
- Energy Intensive Equipment
- Outside/Fresh Air Demands for Health and Safety

ACH (Air Change per Hour)

What is really adequate?

- Many standards
- Range from 4 ACH to 18 ACH
- Using a default ACH is wasteful. Need to calc what's really necessary
- Sensors can increase ACH when needed to save energy and increase occupant health. (no guessing)

HVAC

Modular and Adjustable to Match Load

- Equipment is used more efficiently
- Variable speed systems
- Right sizing
- Increase safety because HVAC responds to needs more accurately

Process Loads

Typically are over estimated (designed for 9-10 W/sf when perhaps only need 4 W/sf)

- Increases first cost (breakers, mechanical equipment, sf for electrical equipment, etc.)
- Electrical Code (220.14A) allows for right sizing, so using a estimate is wasteful.
- Communication/Integration among design team is necessary to design right.

Load Summary

BUILDING	KVA TRANSFORMER	AMPS DESIGNED	ACTUAL AMPS USED	% USED
CLIENT 1	3000/4000	4000	985	25%
CLIENT 2		3000	786	26%
B6 PANEL DB ML1		2000	179	9%
B6 PANEL MSEA		3000	612	20%
B6 PANEL EMHA		1200	394	33%
B10 MSA	4000	4000		
B1 MSB		3000	314	10%
B5 EMHA	2000	2500	259	10%
B5 MSDA	3000/4000	4000		
ENTIRE CAMPUS		26000	2847	11%
8 BUILDINGS				

Pricing

SWITCHGEAR PRICING			15 KV TRANSFORMER PRICING	
600A	$ 16,470.00		1000 KVA	$ 51,500.00
800A	$ 21,570.00		1500 KVA	$ 59,500.00
1200A	$ 28,920.00		2000 KVA	$ 66,000.00
1600A	$ 39,720.00		2500 KVA	$ 77,000.00
2000A	$ 50,520.00		3000 KVA	$ 90,500.00
4000A	$ 95,500.00		4000 KVA	$ 110,000.00
CIRCUIT BREAKERS				
400ACB-30K	$ 3,296.00			
400ACB-65K	$ 12,864.00			
600ACB-30K	$ 6,438.00			
600ACB-65K	$ 17,659.00			
4000 KVA GEAR			**2000 KVA GEAR**	
$ 75,000.00	1 TRANSFORMER		$ 46,000.00	1 TRANSFORMER
$ 115,500.00	3 SECTIONS		$ 65,560.00	3 SECTIONS
$ 76,885.00	15 BREAKERS		$ 46,570.00	15 BREAKERS
$ 267,385.00			$ 158,130.00	
DIFFERENCE	**$ 109,255.00**			

Fume Hoods

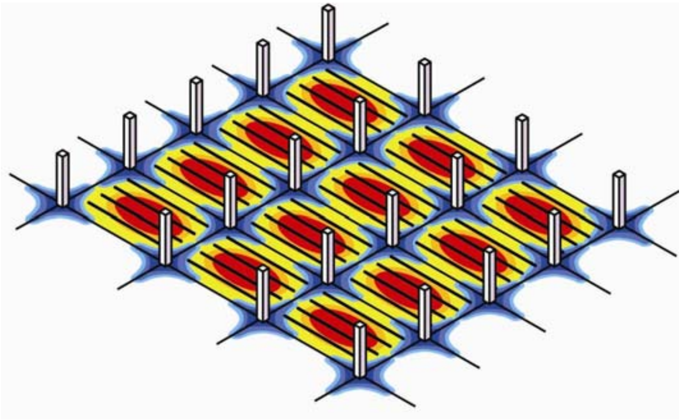
1 Fume hood can consume as much energy as 3 average homes

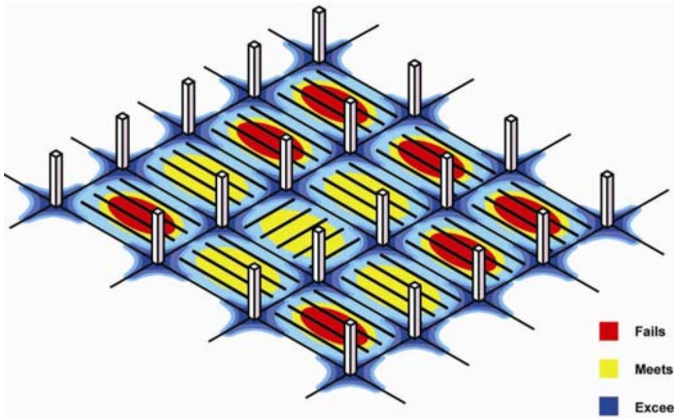
Solutions:

- Make sure there are no unnecessary fume hoods (programming and coordination with EHS)
- Adequate face velocity (60 fpm or 100 fpm)
- Sash placement is important for energy saving and safety (sensors, occupant behavior)
- Use VAV fume hoods and low-volume high performance hood
- Hood location in room is not in circulation path or near a draft.
- Laminar Fume hood (recirculates air)

BIM and Labs

- Vibration and Stiffness
- Daylighting
- Fume Hood Modeling





Labs 21 Toolkit

- Introduction to Low-Energy Design
- Labs21 Video

Core information resources:

- A Design Guide for Energy-Efficient Research Labs
- Best Practice Guides
- Case Studies
- Energy Benchmarking
- Laboratory Equipment Efficiency Wiki

Design process tools:

- Environmental Performance Criteria
- Design Intent Tool
- Labs21 Design Process Manual

http://www.labs21century.gov/toolkit/index.htm

Lab Visits

Conclusion

The challenge for architects, engineers, and other building professionals is to design and construct the next generation of facilities with energy efficiency, renewable energy sources, and sustainable construction practices in mind. And to do so while maintaining — and even advancing — high contemporary standards of comfort, health, and safety.